

IMPROVED ASTIGMATIC FOCUS ERROR DETECTION METHOD

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All easy-to-implement focus- and track-error detection methods presently used in magneto-optical (MO) disk drives using pre-grooved media suffer from a side effect known as feedthrough. Feedthrough is the unwanted focus error signal (FES) produced when the optical head is seeking a new track, and light refracted from the pre-grooved disk produces an erroneous FES. Some focus- and track-error detection methods are more resistant to feedthrough, but tend to be complicated and/or difficult to keep in alignment as a result of environmental insults. The astigmatic focus/push-pull tracking method is an elegant, easy-to-align focus- and track-error detection method. Unfortunately, it is also highly susceptible to feedthrough when astigmatism is present, with the worst effects caused by astigmatism oriented such that the tangential and sagittal foci are at 45° to the track direction.

This disclosure outlines a method to nearly completely eliminate the worst-case form of feedthrough due to astigmatism oriented 45° to the track direction. Feedthrough due to other primary aberrations is not improved, but performance is identical to the unimproved astigmatic method.

The new method works as follows: Light returning from the pre-grooved disk is split by a polarizing beam splitter into two equal halves when no MO signal is present. One path contains an astigmat oriented such that its axis is +45° to the track direction. The other astigmat is oriented with its axis -45° to the track direction and 90° with respect to the first astigmat. Quadrant detectors are positioned midway between the two astigmatic foci in the usual manner. Figure 1 depicts the scheme. The enhanced improvement over the common implementation is caused by the 90° rotation in the intensity pattern on each detector. As the head is moving across the tracks in the presence of astigmatism, the intensity pattern on the quadrant detector becomes elliptical in symmetry, with its major axis rotating 90° as the beam scans across the land and groove. One adds the quadrant signals in the following way

$$FES_{\text{new}} = \frac{\frac{((I+III)-(II+IV))_{D1}}{(I+II+III+IV)_{D1}} - \frac{((I+III)-(II+IV))_{D2}}{(I+II+III+IV)_{D2}}}{2}$$

and this deleterious effect is canceled. Figure 2 shows the unimproved feedthrough plot for the astigmatic method. Defocus is added to improve the Strehl ratio in the case of spherical aberration. Figure 3 shows the increased performance with the newly invented differential approach. Figure 4 shows the increased performance with expanded scale.

This method is beneficial since it can be implemented easily in most existing designs, and also permits simultaneous differential detection of the MO data signal.

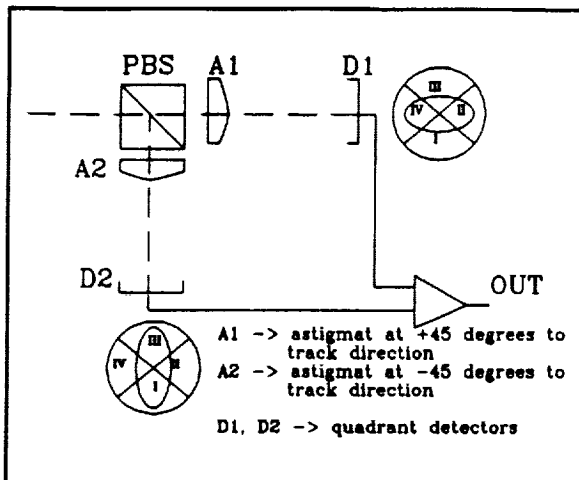


Figure 1. Layout of improved astigmatic focus error detection method.

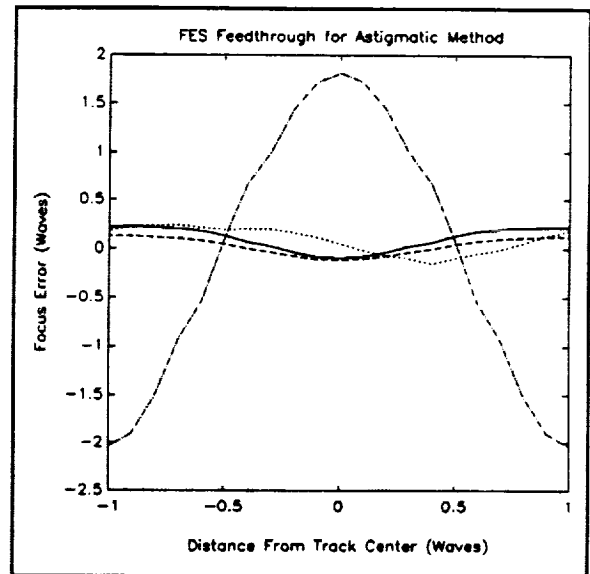


Figure 2. FES feedthrough for astigmatic/push-pull method for no aberrations (solid), $+0.25 \lambda$ spherical aberration (dash), $+0.25 \lambda$ astigmatism (dash-dot), and $+0.25 \lambda$ coma (dot).

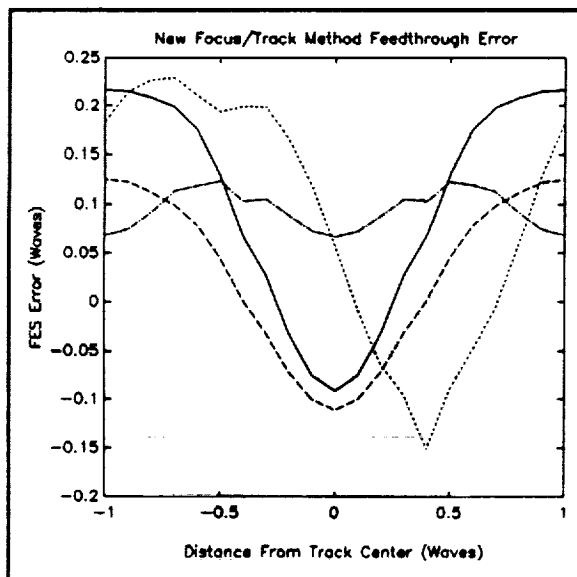


Figure 4. Feedthrough signal on expanded scale. No aberration (solid), $+0.25 \lambda$ spherical aberration (dash), $+0.25 \lambda$ astigmatism (dash-dot), and $+0.25 \lambda$ coma (dot).

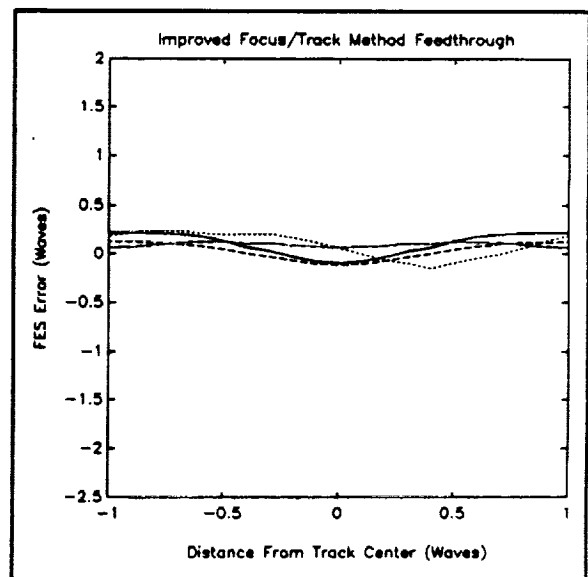


Figure 3. Improved astigmatic focus/track method with no aberrations (solid), $+0.25 \lambda$ spherical aberration (dash), $+0.25 \lambda$ astigmatism (dash-dot), and $+0.25 \lambda$ coma (dot).

APPENDIX C
